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## (54) TACTILE SWITCH USING PIEZOELECTRIC ELEMENT

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a tactile switch using a piezoelectric element capable of acquiring a response with the sense of touch corresponding to a switch operation in a simple configuration where any special driving circuit is not installed, and performing a certain and stable switch operation.

**SOLUTION:** A bimorph element 1 is disposed under a key top 2, and distorted and deflected. In this case, the back central part of the bimorph element is supported by a supporting body 3, and the key top bottom face is formed so as to be recessed. When the key top is depressed, the bimorph element is distorted and deflected so as to be fit into the recessed shape, and the back electrode film is brought into contact with holding pieces 5 and 5 so that a ground side can be made conductive. Then, an intermediate electrode layer 10 is brought into contact with a make contact 6, and a circuit for detecting a charge is closed. The distortion and deflection of the bimorph element is limited so that the generated charge quantity can be made constant, and the charge is allowed to circulate through the closed circuit and detected, and the on-state is set. The bimorph develops reaction force to restore the distortion/deflection by the discharge of the charge, and this reaction force is shockingly transmitted to the key top 2 so that the sense of touch can be realized.

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## CLAIMS

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[Claim(s)]  
[Claim 1] The bimorph element equipped with the piezoelectric device which is the tactile feeling switch which has a tactile response to switch actuation of push actuation etc., is distorted according to external force and generates a charge. An external force operation means to tell the applied force in said switch actuation to said piezoelectric device, and to make predetermined distorted. The tactile feeling switch using the piezoelectric device characterized by enabling discharge of the charge which was equipped with make contact which connects with the piezoelectric device distorted to predetermined with said external force operation means electrically, formed the circuit stood in a row and traveled from the make contact concerned to the other end of said piezoelectric device, and was stored in said piezoelectric device.  
[Claim 2] Said external force operation means is a tactile feeling switch using the piezoelectric device according to claim 1 characterized by having the base material which supports the rear-face center section of said piezoelectric device, and the keytop arranged in the upper part of said piezoelectric device with the base of a concave configuration, contacting said piezoelectric device by switch actuation of pushing the keytop concerned, and making it distorted in accordance with the concave configuration of the base concerned.  
[Claim 3] It is a tactile feeling switch using the piezoelectric device according to claim 2 which is the rigid-body layer which a lower layer side does not deform for

said keytop, and is characterized by an upper layer side considering as the quality-of-the-material structure of two or more layers which is an elastic body layer with flexibility.

[Claim 4] It is a tactile feeling switch using the piezoelectric device according to claim 2 which is the rigid-body section which does not deform the lower part for said keytop, and is characterized by making the upper part into the functional structure of two steps of upper and lower sides which stand in a row through elastic members, such as a spring.

[Claim 5] Said piezoelectric device is a tactile feeling switch using a piezoelectric device given in any 1 term of claims 2–4 which a vertical layer is the same direction, connects electrically a top-face electrode and an inferior-surface-of-tongue electrode, and the direction of polarization considers as a common electrode, and are characterized by taking out a charge from between bipolar electrode layers.

[Claim 6] Said piezoelectric device is a tactile feeling switch using a piezoelectric device given in any 1 term of claims 2–4 which the direction of polarization is hard flow in a vertical layer, and are characterized by taking out a charge from between a top-face electrode and inferior-surface-of-tongue electrodes.

[Claim 7] The tactile feeling switch using a piezoelectric device given in any 1 term of claims 1–6 characterized by having prepared light emitting devices, such as LED, in said circuit, and enabling lighting of said light emitting device with discharge of said charge.

[Claim 8] The tactile feeling switch using a piezoelectric device given in any 1 term of claims 1–7 characterized by equipping said circuit with rectification accumulation-of-electricity means, such as diode for arranging are recording of the charge in said piezoelectric device with a predetermined polarity.

[Claim 9] The tactile feeling switch using a piezoelectric device given in any 1 term of claims 1–8 characterized by having the charge discharge means which forms the circuit stood in a row and traveled to the other end of said piezoelectric device from the stationary contact which connects with said piezoelectric device electrically in a stationary location, and the stationary contact concerned, and discharges a charge.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

#### [0001]

[Field of the Invention] This invention relates to amelioration of the basic configuration of the tactile feeling switch which a bimorph element is made distorted by switch actuation of push actuation etc., and was more specifically made to detect the generating charge about the tactile feeling switch which used the piezoelectric

device.

[0002]

[Background of the Invention] Since the piezoelectricity effectiveness of a piezoelectric device being distorted according to external force, and generating a charge is shown, using this for a switching device is performed as known well. For example, it has applied to the key switch which performs push actuation, and has become switching which a piezoelectric device is made distorted by the push operating physical force, and obtains an ON state from detection of a generating charge (electrical potential difference).

[0003] Moreover, there are some which were shown in JP,10-307661,A etc. in the switch using a piezoelectric device. The thing of this official report is constituted so that distortion deformation may be given to the bimorph element of the keypad lower part concerned by carrying out push actuation of the keypad. And the driving signal which carried out predetermined time delay from the output of the detection signal of a generating charge for the tactile response was generated, and the configuration equipped with the feedback circuit which applies the high voltage to a bimorph element to the timing of this driving signal is taken.

[0004] For this reason, if push actuation of the keypad is carried out, while detecting the generating charge by distortion deformation of a bimorph element and obtaining an ON state, since the reaction force to which a bimorph element returns that distortion by actuation of a feedback circuit is discovered and the so-called back pressure electrical-and-electric-equipment effectiveness is shown, an operator will perceive that reaction force (response) tactile, and tactile feeling is obtained.

[0005] However, with the switch shown in the above-mentioned official report, in order to obtain a tactile response, a feedback circuit is required, since it moreover becomes the drive circuit of the high voltage, components increasing in number and becoming large-scale is not avoided, but cost becomes high. Moreover, since there is a background that the demand of a miniaturization is high about an electronic instrument recently, in an attachment circuit becoming large-scale as mentioned above, it is not suitable for small and lightweight-ization.

[0006] The place which this invention was made in view of the above-mentioned background, and is made into the purpose can solve the above-mentioned problem, can take the simple configuration which does not prepare a special drive circuit, can obtain a tactile response to switch actuation, and is to offer the tactile feeling switch using the piezoelectric device which can perform certain and stable switching.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the tactile feeling switch using the piezoelectric device concerning this invention is a tactile feeling switch which has a tactile response to switch actuation of push actuation etc. And it had the bimorph element equipped with the piezoelectric device which is distorted according to external force and generates a charge, an external-force operation means tell the applied force in said switch actuation to said

piezoelectric device, and make predetermined distorted, and make contact that connect with the piezoelectric device distorted to predetermined with said external-force operation means electrically, and the charge which formed the circuit which stands in a row and travels from the make contact concerned to the other end of said piezoelectric device, and was stored in said piezoelectric device constituted possible [ discharge ].

[0008] Moreover, said external force operation means is equipped with the base material which supports the rear-face center section of said piezoelectric device, and the keytop arranged in the upper part of said piezoelectric device with the base of a concave configuration, and makes it the configuration which said piezoelectric device is contacted [ configuration ] by switch actuation of pushing the keytop concerned, and makes the concave configuration of the base concerned distorted.

[0009] Moreover, it is the rigid-body layer which a lower layer side does not deform for said keytop, and an upper layer side considers as the vertical two-layer quality-of-the-material structure which is an elastic body layer with flexibility, or it is the rigid-body section which does not deform the lower part, and let the upper part be the functional structure of two steps of upper and lower sides which stand in a row through elastic members, such as a spring, again.

[0010] Moreover, it is the same direction, and a vertical layer connects electrically a top-face electrode and an inferior-surface-of-tongue electrode, and the direction of polarization uses it as a common electrode, and makes said piezoelectric device the configuration which takes out a charge from between bipolar electrode layers. Or the configuration that the direction of polarization is hard flow in a vertical layer, and takes out a charge from between a top-face electrode and inferior-surface-of-tongue electrodes is sufficient as said piezoelectric device again.

[0011] Moreover, it is good for said circuit to prepare light emitting devices, such as LED, and to constitute said light emitting device possible [ lighting ] with discharge of said charge. It is still better for said circuit to have rectification accumulation-of-electricity means, such as diode for arranging are recording of the charge in said piezoelectric device with a predetermined polarity.

[0012] Moreover, it has the charge discharge means which forms the circuit stood in a row and traveled to the other end of said piezoelectric device from the stationary contact which connects with said piezoelectric device electrically in a stationary location, and the stationary contact concerned, and discharges a charge.

[0013] Therefore, in this invention, distortion deformation is carried out in the condition that a bimorph element meets a concave configuration by pushing a keytop, and the circuit which contacts make contact soon and detects a charge closes. Here, since distortion deformation of a bimorph element is restricted to the concave configuration at the base of a keytop, the amount of charges to generate serves as a predetermined value. This charge flows a closed circuit by connection of make contact, it can detect from luminescence of light emitting devices, such as LED, and an ON state is obtained. Since a bimorph element discovers reaction force to the

sense which returns distortion deformation by emitting a generating charge at this time, propagation and the operator who did switch actuation will do tactile feeling shockingly [ this return reaction force ] to a keytop.

[0014]

[Embodiment of the Invention] Drawing 1 shows the gestalt of operation of the 1st of this invention. In the gestalt of this operation, the tactile feeling switch was equipped with the bimorph element 1 which is distorted according to external force and generates a charge, and has taken the configuration which gives distortion deformation to the bimorph element 1 of the keytop 2 lower part concerned by carrying out push actuation of the keytop 2. And are switching which obtains an ON state from detection (discharge) of a generating charge, the reaction force which returns distortion to a bimorph element 1 by rapid discharge produced in case the ON state is obtained is made to discover, and a tactile response is obtained.

[0015] A bimorph element 1 has the multilayer structure in which the electrode layer was formed on the front face of each piezo-electric layer 11 and 12 while forming the piezo-electric layers 11 and 12 which consist of a piezoelectric device by a ceramic ingredient etc. so that the bipolar electrode layer 10 may be pinched. A vertical layer is the same direction, connects a top-face electrode and an inferior-surface-of-tongue electrode with lead wire 13, the direction of polarization uses a bimorph element 1 as a common electrode, and he is trying to take out a charge from between the bipolar electrode layers 10 with the gestalt of this operation, as shown in drawing 2.

[0016] The keytop 2 has fabricated the base in the concave configuration, is the rigid-body layer 20 which a vertical two-layer quality-of-the-material structure, i.e., lower layer, side does not deform, and has become the elastic body layer 21 in which an upper layer side has flexibility. This is for enlarging the amount of strokes of switch actuation of pushing a keytop 2. That is, although the amount of actuation strokes cannot be enlarged so much for carrying out distortion deformation of the bimorph element 1 within the limits of an elasticity limit, it is desirable to set up the to some extent big amount of actuation strokes for making an operator sense clear actuation feeling. Then, by setting up appropriately the concave configuration of the base of the rigid-body layer 20 within the limits of the elasticity limit of piezoelectric material, by inhibiting deforming more greatly than the concave configuration, and forming the elastic body layer 21 further, when the elastic body layer 21 which starts at the time of the depression accompanying switch actuation carried out elastic deformation, the amount of actuation strokes was secured.

[0017] In addition, as a keytop 2, since only a base holds a configuration, it is not limited to the vertical two-layer quality-of-the-material structure shown in the gestalt of this operation. For example, it considers as the rigid-body section which does not deform the lower part, and the upper part is good also as a functional structure of two steps of upper and lower sides which stand in a row through elastic members, such as a spring. Of course, it is good as for three or more layers.

- [0018] And the abbreviation rectangle-like base material 3 is formed on the base plate 4, and a bimorph element 1 takes the configuration which fixes on a base material 3 and supports that rear-face center section, and is made distorted in this tactile feeling switch in the condition of contacting a bimorph element 1 by switch actuation of pushing a keytop 2, and meeting the concave configuration of the base concerned. Moreover, the pieces 5 and 5 of maintenance are formed in the both sides of a base material 3, the bimorph element 1 which carried out distortion deformation contacts the base configuration of a keytop 2, and this is supported.
- [0019] A base material 3 and the pieces 5 and 5 of maintenance are formed from the elastic member, and are taken as a setup harder than the elastic body layer 21 of a keytop 2. Furthermore, the pieces 5 and 5 of maintenance are the earth side contacts of the closed circuit which stands in a row at the contact which mixes and mentions a conductive member later.
- [0020] Although illustration was omitted to drawing 1, make contact 6 is formed in the base plate 4, and this make contact 6 is set up so that it may connect with the bimorph element 1 which carried out distortion deformation electrically predetermined. With the gestalt of this operation, as shown in drawing 5 (b), the overhang section of the bipolar electrode layer 10 is contacted. Moreover, the stationary contact 7 is arranged above make contact-6, the stationary contact 7 is considered as a setup electrically connected to a bimorph element 1 in a stationary location, and with the gestalt of this operation, as shown in drawing 3 (b), the overhang section of the bipolar electrode layer 10 is contacted.
- [0021] As shown in drawing 2, the resistance 60 for current limiting, serial Rhine of LED61, and Rhine of the rectification accumulation-of-electricity diode 62 are connected to juxtaposition, and these Rhine forms in make contact 6 the circuit connected to the other end of a bimorph element 1 from the make contact 6 concerned. This rectification accumulation-of-electricity diode 62 is connected to the reverse sense in LED61. Therefore, since the charge which the bimorph element 1 generated according to distortion deformation is emitted to the LED61 side as forward current, it emits light, and it can detect a charge. And are recording of a charge will take place to a bimorph element 1 at the reverse sense, and this is made to discharge by direction limit of the rectification accumulation-of-electricity diode 62 then in the discharge circuit which stands in a row at the stationary contact 7.
- [0022] That is, as shown in drawing 2, the resistance 70 for charge discharge is connected to the stationary contact 7, and this forms the circuit stood in a row and traveled from the stationary contact 7 concerned to the other end of a bimorph element 1. Therefore, when a bimorph element 1 is in a stationary location, the charge accumulated in this is emitted to resistance 70.
- [0023] In addition, the circuit pattern is formed in the rear face of the base plate 4, and the circuit element of the resistance 60 described above to the circuit pattern, LED61, the rectification accumulation-of-electricity diode 62, and resistance 70 grade is mounted.

[0024] In the bimorph element 1 which carried out distortion deformation in the condition of meeting the concave configuration of keytop 2 base, the upper piezo-electric layer 11 is prolonged and it is deformed, and the lower piezo-electric layer 12 is shrunken and it is deformed. And as for the polarity of a generating charge, a stretch deformation side becomes the sense which gathers in the direction of polarization, and a shrinkage deformation side becomes the direction of polarization, and the reverse sense. Since a vertical layer has the same direction of polarization, as shown in drawing 2, the polarity of a charge will gather to the bipolar electrode layer 10, and the piezo-electric layer 11 and the piezo-electric layer 12 will be connected to parallel here. The tactile feeling switch which relates to this invention here operates as follows.

[0025] (1) When a tactile feeling switch is in a steady state, as shown in drawing 3, the pieces 5 and 5 of maintenance of make contact 6 and an earth side contact are non-contact.

[0026] (2) If a keytop 2 is pushed here, the rear face (electrode layer) of a bimorph element 1 will contact the pieces 5 and 5 of maintenance, the earth side will be in switch-on first, and it is begun to compress the pieces 5 and 5 of maintenance and base material 3 which have elasticity to carry out distortion deformation in the condition that the bimorph element 1 which had the center supported meets the concave configuration of keytop 2 base, and to be shown in drawing 4. Since the distortion deformation of this bimorph element 1 is decided by the concave configuration of keytop 2 base and sets up that concave configuration appropriately within the limits of the elasticity limit of piezoelectric material, a bimorph element 1 does not damage it.

[0027] (3) The closed circuit where the overhang section of the bipolar electrode layer 10 will contact make contact 6, will be in switch-on, and detects a charge by pushing in a keytop 2 further as shown in drawing 5 (b) is made.

[0028] Therefore, the generating charge of a bimorph element 1 emits and LED61 emits light. Since a bimorph element 1 discovers reaction force to the sense which returns distortion deformation by emitting a generating charge rapidly at this time, propagation and the operator who did switch actuation will do tactile feeling shockingly [this return reaction force] to a keytop 2.

[0029] (4) Although it returns to the steady state which the distortion configuration of a bimorph element 1 returns and is shown in drawing 3 when an operator detaches a keytop 2 and push actuation is stopped, are recording of the charge by the rectification accumulation-of-electricity diode 62 has taken place to the bimorph element 1 at the reverse sense at this time. Since this stored charge is set off against the generating charge by next switching, it is necessary to discharge, and the bipolar electrode layer 10 will contact the stationary contact 7, and will be in switch-on, and a charge is made to emit in this invention in the closed circuit involving resistance 70.

[0030] Thus, in this invention, distortion deformation is carried out in the condition

that a bimorph element 1 meets a concave configuration by pushing a keytop 2, and it connects and closes in the circuit which contacts make contact 6 soon and detects a charge. Here, since distortion deformation of a bimorph element 1 is restricted to the concave configuration of keytop 2 base, the amount of charges to generate serves as a predetermined value, this charge flows, and can detect a closed circuit from luminescence of LED61, and an ON state is obtained. And since a bimorph element 1 discovers reaction force to the sense which returns distortion deformation by emitting a generating charge, this return reaction force can obtain a tactile response to propagation and switch actuation shockingly to a keytop 2.

[0031] In this case, like before, a feedback circuit is unnecessary for obtaining a tactile response, and becomes it with the simple configuration of not preparing a special drive circuit. For this reason, it is profitable in respect of cost, and small and lightweight-ization can be attained.

[0032] Moreover, since distortion deformation of a bimorph element 1 is the specified quantity, the amount of generating charges by this can become fixed, for this reason, an ON state can be obtained stably, and certain and stable switching can be performed.

[0033] Drawing 9 shows the gestalt of operation of the 2nd of this invention from drawing 6. With the gestalt of this 2nd operation, the direction of polarization of a bimorph element 1 is changed. That is, although it is the same as that of the thing of the gestalt of the 1st operation to use as the piezo-electric layers 11 and 12 by a ceramic ingredient etc. the upper and lower sides whose bipolar electrode layer 10 is pinched, to form an electrode layer in the front face of the piezo-electric layers 11 and 12, respectively, and to make it multilayer structure, with the gestalt of this operation, a bimorph element 1 forms the top-face electrode layer 14 which \*\*\*\*\*s on the piezo-electric layer 11 and has the section, juts it out over the bipolar electrode layer 10, and does not form the section. And the direction of polarization is hard flow in a vertical layer, and this bimorph element 1 is constituted so that a charge may be taken out from between the top-face electrode layer 14 and inferior-surface-of-tongue electrodes.

[0034] Moreover, the configuration which mixes a conductive member to a base material 3 is taken without mixing a conductive member to the pieces 5 and 5 of maintenance, and since the inferior-surface-of-tongue electrode of a bimorph element 1 fixes with electroconductive glue to a base material 3, it will be connected to the earth side of the circuit which detects a charge. Other each part of a configuration is the same as that of the 1st gestalt, and explanation of each part is omitted like them.

[0035] In addition, in the bimorph element 1 which carried out distortion deformation in the condition of meeting the concave configuration of keytop 2 base, the upper piezo-electric layer 11 is prolonged and it is deformed, and the lower piezo-electric layer 12 is shrunken and it is deformed. And as for the polarity of a generating charge, a stretch deformation side becomes the sense which gathers in the direction

of polarization, and a shrinkage deformation side becomes the direction of polarization, and the reverse sense. Since the direction of polarization is hard flow in a vertical layer, as shown in drawing 6, the polarity of a charge becomes reverse to the bipolar electrode layer 10, and the piezo-electric layer 11 and the piezo-electric layer 12 will be connected to series here. Therefore, the tactile feeling switch of this gestalt operates as follows.

[0036] (1) When a tactile feeling switch is in a steady state, as shown in drawing 7 (b), make contact 6 is non-contact.

[0037] (2) If a keytop 2 is pushed here, to carry out distortion deformation in the condition that the bimorph element 1 which had the center supported meets the concave configuration of keytop 2 base, and to be shown in drawing 8, the rear face (electrode layer) of a bimorph element 1 will contact the pieces 5 and 5 of maintenance, and will begin to compress the pieces 5 and 5 of maintenance, and a base material 3.

[0038] (3) The closed circuit where the overhang section of the top-face electrode layer 14 will contact make contact 6, will be in switch-on, and detects a charge by pushing in a keytop 2 further as shown in drawing 9 (b) is made.

[0039] Therefore, the generating charge of a bimorph element 1 emits and LED61 emits light. Since a bimorph element 1 discovers reaction force to the sense which returns distortion deformation by emitting a generating charge at this time, propagation and the operator who did switch actuation will do tactile feeling shockingly [ this return reaction force ] to a keytop 2.

[0040] (4) Although it returns to the steady state which the distortion configuration of a bimorph element 1 returns and is shown in drawing 7 when an operator detaches a keytop 2 and push actuation is stopped, are recording of the charge by the rectification accumulation-of-electricity diode 62 has taken place to the bimorph element 1 at the reverse sense at this time. Since this stored charge is set off against the generating charge by next switching, it is necessary to discharge, and the top-face electrode layer 14 will contact the stationary contact 7, and will be in switch-on, and a charge is made to emit with this gestalt in the closed circuit involving resistance 70.

[0041]

[Effect of the Invention] As mentioned above, with the tactile feeling switch using the piezoelectric device concerning this invention, distortion deformation is carried out in the condition that a bimorph element meets a concave configuration by pushing a keytop, and the circuit which contacts make contact soon and detects a charge closes. Here, since distortion deformation of a bimorph element is restricted to the concave configuration at the base of a keytop, the amount of charges to generate serves as a predetermined value, this charge flows, and can detect a closed circuit from luminescence of light emitting devices, such as LED, and an ON state is obtained. And since a bimorph element discovers reaction force to the sense which returns distortion deformation by emitting a generating charge, this

return reaction force can obtain a tactile response to propagation and switch actuation shockingly to a keytop.

[0042] In this case, like before, a feedback circuit is unnecessary for obtaining a tactile response, and becomes it with the simple configuration of not preparing a special drive circuit. For this reason, it is profitable in respect of cost, and small and lightweight-ization can be attained.

[0043] Moreover, since distortion deformation of a bimorph element is the specified quantity, the amount of generating charges by this can become fixed, for this reason, an ON state can be obtained stably, and certain and stable switching can be performed.

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## DESCRIPTION OF DRAWINGS

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### [Brief Description of the Drawings]

[Drawing 1] It is the perspective view of the tactile feeling switch in which the gestalt of operation of the 1st of this invention is shown.

[Drawing 2] It is the block diagram of the tactile feeling switch concerning this invention.

[Drawing 3] (a) is the front view of a tactile feeling switch. (b) is the side elevation.

[Drawing 4] (a) is the front view of a tactile feeling switch. (b) is the side elevation.

[Drawing 5] (a) is the front view of a tactile feeling switch. (b) is the side elevation.

[Drawing 6] It is the block diagram of the tactile feeling switch in which the gestalt of operation of the 2nd of this invention is shown.

[Drawing 7] (a) is the front view of a tactile feeling switch. (b) is the side elevation.

[Drawing 8] (a) is the front view of a tactile feeling switch. (b) is the side elevation.

[Drawing 9] (a) is the front view of a tactile feeling switch. (b) is the side elevation.

### [Description of Notations]

1 Bimorph Element

2 Keytop

3 Base Material

4 Base Plate

5 Piece of Maintenance

6 Make Contact

7 Stationary Contact

10 Bipolar Electrode Layer

11 12 Piezo-electric layer

13 Lead Wire

14 Top-Face Electrode Layer

20 Rigid-Body Layer

**21 Elastic Body Layer**

**60 70 Resistance**

**61 LED**

**62 Rectification Accumulation-of-Electricity Diode**

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